SECTION 5

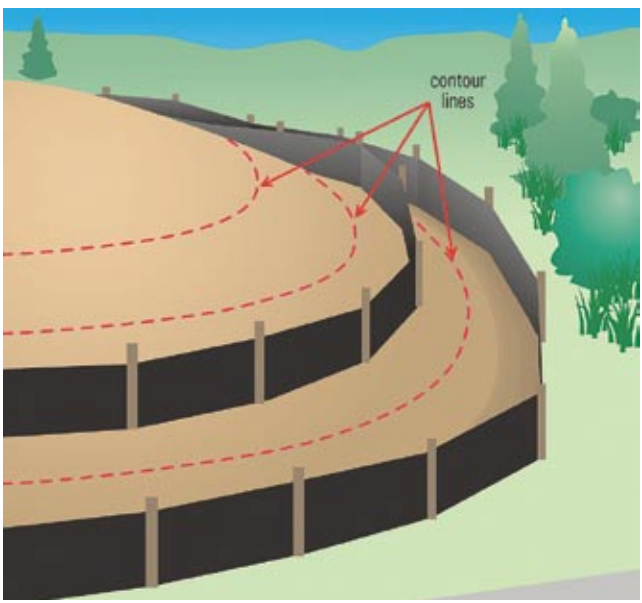
Using Silt Fence and Other Sediment Barriers

The use of silt fences and other sediment barriers involves simple observation and common sense. However, as Will Rogers once noted, “common sense ain’t so common.” The following summary provides details on how to install sediment barriers.

Sediment barrier placement

Sediment barriers—silt fences or rock filters—are required below (downhill from) areas of bare soil. Hay or straw bales must not be used as sediment filters due to their inherent weakness and tendency to fall apart. There are several factors to consider in placing silt fences, rock sediment filters, or other commercial sediment barriers:

- Place filters on downhill edge of bare soil areas.
- Make sure the filter catches all the muddy runoff.
- The goal is to pond runoff, to filter and settle it out.
- Install multiple sediment filters on long slopes.
- Spacing on long slopes is every 60 to 110 feet.
- Put filters across slopes, on the contour (level).



Silt fences should be installed on the contour below bare soil areas. Use multiple fences on long slopes 60 to 80 feet apart. Remove accumulated sediment before it reaches halfway up the fence.

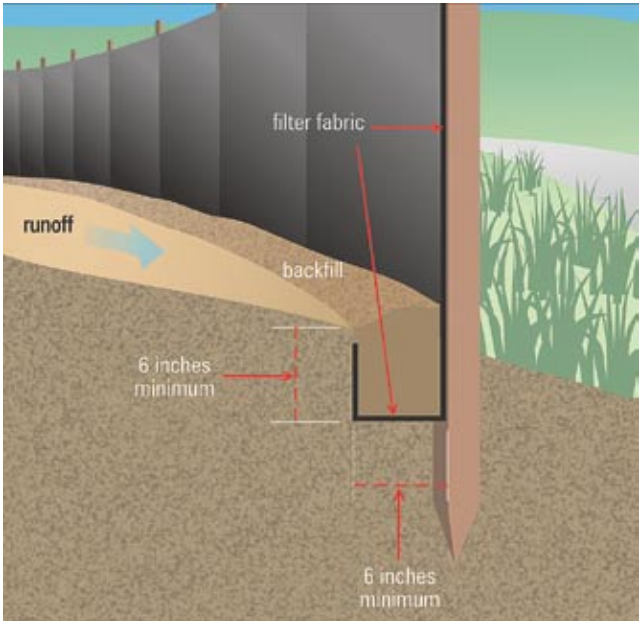
Silt fence installation

Each 100-foot section of silt fence can filter runoff from about ¼ acre (about 110 feet uphill). To install a silt fence correctly, follow these steps:

- Note the location & extent of the bare soil area.
- Mark silt fence location just below bare soil area.
- Make sure fence will catch all flows from area.
- Dig trench 6 inches deep across slope.
- Unroll silt fence along trench.
- Join fencing by rolling the end stakes together.
- Make sure stakes are on downhill side of fence
- Drive stakes in against downhill side of trench.
- Drive stakes until 8 to 10 inches of fabric is in trench.
- Push fabric into trench; spread along bottom.
- Fill trench with soil and tamp down.

Silt fencing should not be installed:

- Up and down hills.
- Above (uphill from) areas of bare soil.
- In ditches, channels, or streams.



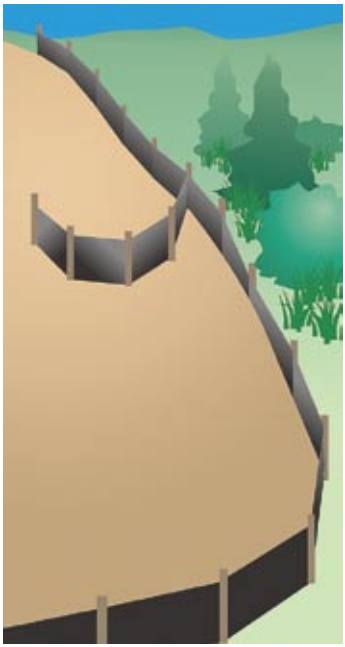
Remember: stakes go on the downhill side. Dig trench first, install fence in downhill side of trench, tuck fabric into trench, then backfill on the uphill side (the side toward the bare soil area).

Silt fence spacing on sloping sites

	Soil Type		
Slope Angle	Silty	Clays	Sandy
Very Steep (1:1)	50 ft.	75 ft.	100 ft.
Steep (2:1)	75 ft.	100 ft.	125 ft.
Moderate (4:1)	100 ft.	125 ft.	150 ft.
Slight (10:1)	125 ft.	150 ft.	200 ft.

For silt fences treating high flows from steep slopes, reinforce the silt fence with woven wire and metal fence posts. Install wire fencing *between* the posts and the silt fence filter fabric, so pressure on the fabric from uphill flows is distributed across the wire fencing, then to the posts.

If muddy runoff flows along the uphill side of a silt fence, install "J-hooks" every 40 to 80 feet. These are curved sections of silt fence that act as small dams to stop, pond up, and filter or settle out flows (see illustration).



Use J-hooks to trap and pond muddy runoff flowing along uphill side of silt fence. Turn ends of silt fence toward the uphill side to prevent bypassing. Use multiple J-hooks every 50 to 150 feet for heavier flows.

Silt fence slicing devices

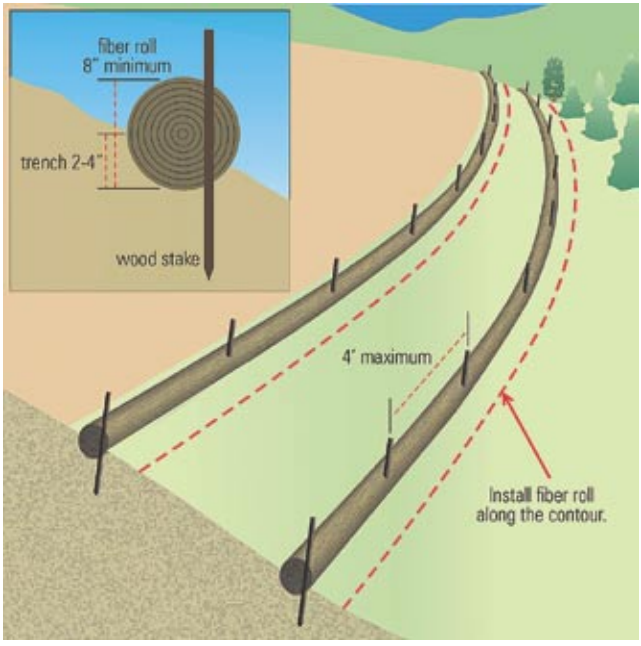
New tractor-mounted equipment that "slices" silt fence into the ground can provide a better installation than the open trench method. The equipment uses a chisel-point or vibratory plow to create a narrow slit in the ground. Rolled silt fencing is pushed into the slit, creating a very tight seal that prevents water from blowing out the bottom of the fence. Posts are driven and attached to the fence after the fencing is installed.

Besides better performance, the slicing method is also faster. For slicing and all other applications, posts are spaced 6 feet apart or less.

Other sediment barriers

Brush cleared from the site can make an excellent sediment filter if it is properly placed (see previous illustration) and built up well. Brush barriers are installed on the contour and are 2 to 5 feet high and 4 to 10 feet wide at the base. Walk them down slightly with a loader or dozer to compress the material in the brush barrier. Stuff additional brush on the uphill side where bypasses or undercutting are evident.

Fiber rolls and other commercial products made from coconut fiber, plastic, wood shavings, or other material can also be used as sediment barriers on slopes flatter than 10:1. Follow manufacturers' installation instructions and ensure that sediment filter spacing on slopes is correct. Make sure runoff does not bypass brush barrier, coconut rolls, or other barriers underneath or around the ends.

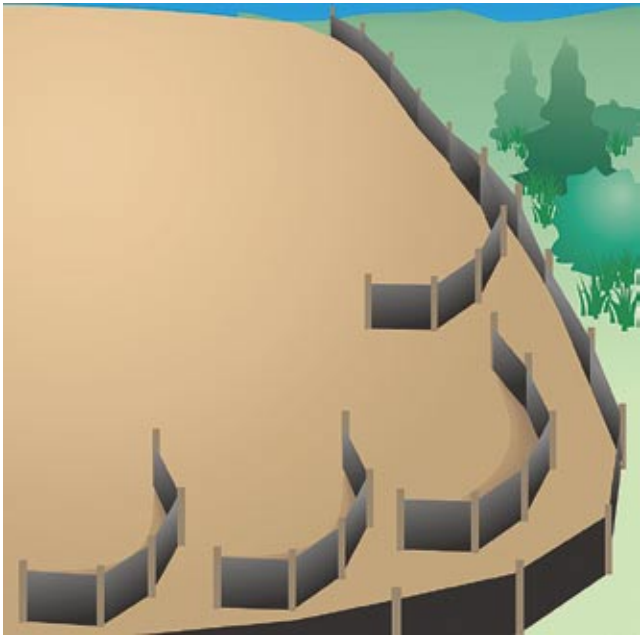


Fiber rolls can be used to break up runoff flows on long slopes. Install on the contour and trench in slightly. Press rolls firmly into trench and stake down securely. Consult manufacturer's instructions for expected lifespan of product, slope limits, etc. As always, seed and mulch long slopes as soon as possible.

Maintenance of sediment barriers

Sediment collecting behind silt fences must be removed before it is halfway up the fence. Move collected sediment to a vegetated area or other place where it will not wash into ditches, channels, or streams. Re-trench and tamp down fencing that is undercut by gullies.

Stop uphill gully formation by grading, seeding, and mulching, or filling with rock, soil, brush, or other material. Use erosion control blankets or turf reinforcement mats to control large areas of uphill erosion. Replace broken or bent-over stakes. Inspect places where fences are joined to make sure joint is solid. Install J-hooks where water flows along silt fence if necessary. Remove all silt fences and grade and seed the area when grass is established, before the project is completed.



Silt fences don't have to be on the property line. Placing them on slopes with the ends turned up to trap sheet flow provides better performance. Stagger fence sections to ensure total coverage. Clean out before sediment reaches halfway up. Repair as needed, and remove when grass is well established.

Very good use of continuous "super" (reinforced) silt fence and shot rock sediment barrier (far side) to filter muddy runoff from commercial development site. Note that wire fencing is installed between the filter fabric and the posts.

Good use of J-hook in silt fence to trap sediment in water running along fence. Sediment must be removed before it reaches halfway to top of fence.

Good installation of silt fence at toe of slope. Do not pile soil or other material on silt fences! Also, if space is available move fence back from toe of slopes to allow room for sediment accumulation and maintenance. Leaving a strip of vegetation between bare soil and fence also improves performance.

Very good installation of multiple silt fences on long slope. Turn ends of fencing uphill to prevent bypass. Leave silt fences up until grass is well established on all areas of the slope. Re-seed bare areas as soon as possible. Remove or spread accumulated sediment and remove silt fence after all grass is up.

Poor installation where silt fences are joined. Roll end stakes together before driving in to create an unbroken sediment barrier or lap curved sections to prevent bypasses. Leaving grass strip between silt fence and bare soil area is a good idea.

Poor installation of silt fencing, fair to good seeding. Silt fence must be trenched in along bottom. Straw bales are not approved as sediment barriers.

Sediment barrier installed backwards. Silt fence fabric should face bare soil area. Stakes go on downhill side. Straw bales can be used to back up fence on downhill side, but not alone.

Very poor attention to silt fence maintenance. Fences and other sediment controls must be inspected and repaired weekly; activities should be logged.

Poor sediment filter installation, no curb inlet protection. Bales alone provide poor protection (note mud on pavement). Very good seed application.

Tractor mounted silt fence slicing devices cut a slit into the ground and push fabric in. Installation is quicker and performance is better than the open trench method, making this approach attractive for large sites.

Excellent example of J-hook installation to intercept muddy runoff flowing along silt fence. Good temporary seeding and mulching (right side).

Good application of silt fence to protect drop inlet (see Section 7). Make sure fencing is trenched in and soil around fabric is compacted.

SECTION 6

Protecting Slopes to Prevent Gullies

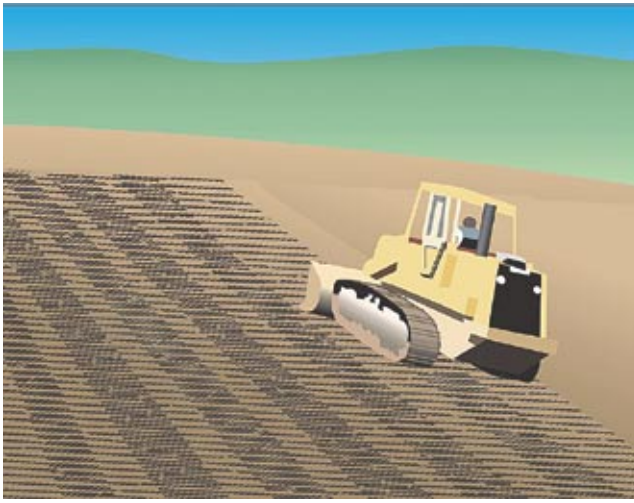
Slopes—especially long ones—must be protected to prevent sheet, rill, and gully erosion. Slopes are stabilized immediately after grading work is completed. Seeding and mulching provide the best and cheapest protection. Erosion control blankets or turf reinforcement mats are needed on most slopes greater than 3:1 (see Section 4).

Approximate slope conversions

Percent	Slope ratio	Degrees
100%	1:1	45°
50%	2:1	27°
33%	3:1	18°
25%	4:1	14°
10%	10:1	6°

Assessing slopes and soils

Steeper slopes (3:1 or steeper) require more protection than flatter slopes. Slopes with highly erodible soils (silty soils) need more protection than those with less erodible soils (sands and gravels). Also, long slopes (greater than 50 feet) are at greater risk for erosion than short slopes.



Tread-track slopes up and down hill to improve stability.

Slope protection basics

Protecting slopes from erosion requires several actions that must be taken together. No single approach will be successful, especially if the slope is long, steep, or has highly erodible soils (see table). Use one or more of the following actions to reduce erosion on slopes:

Divert upland runoff

See Section 3 for information on how to install a berm or channel above the slope to divert upland rain runoff around the bare soil area.

Control slope runoff

If slopes are broken up into benches or steps, runoff can be collected and diverted along berms or in channels to pipe or open channel slope drains with stable outlets.

Till seedbed or condition the soil

Dozer tracks up and down slopes help hold soil in place and lengthen the runoff flow path down the slope. See the table for information on how the condition of the soil surface (compacted, tracked, etc.) can increase or decrease erosion.

Seed and mulch

The best and cheapest protection by far. See Section 4 for details on seed types, application rates, and mulch, blanket, and mat products.

Silt fence or other barrier

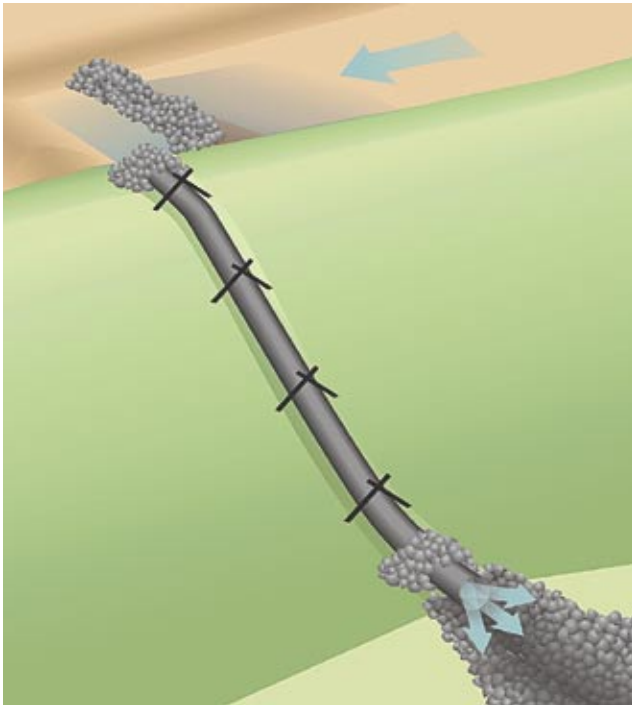
These should be installed at the toe of the slope or slightly away from the toe, and every 75 to 125 feet apart on long slopes. Fiber rolls installed on the contour work very well in breaking up flows on long slopes.

Retaining wall

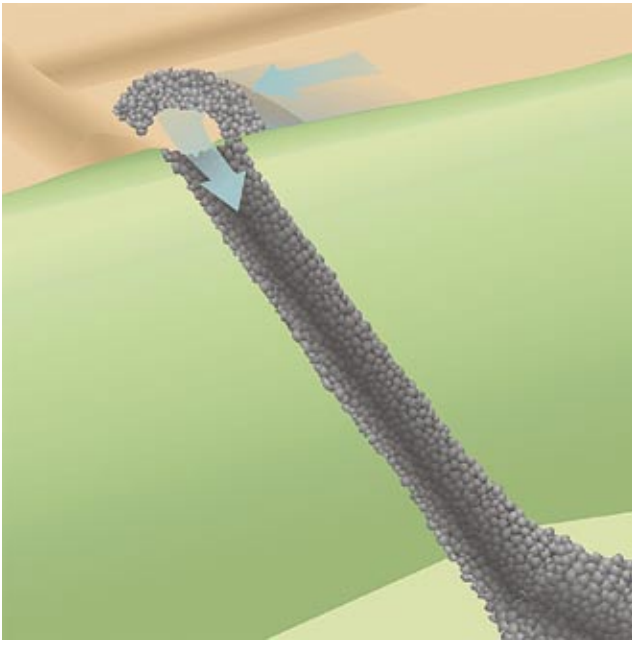
Extremely steep slopes can be leveled out and shortened into two or more steps or benches by installing retaining walls of rock, brick, block, wood, logs, or other material. If rock layers are present along the slope, use these to establish firm benches in a stair-step pattern.

Blankets, mats, or armoring

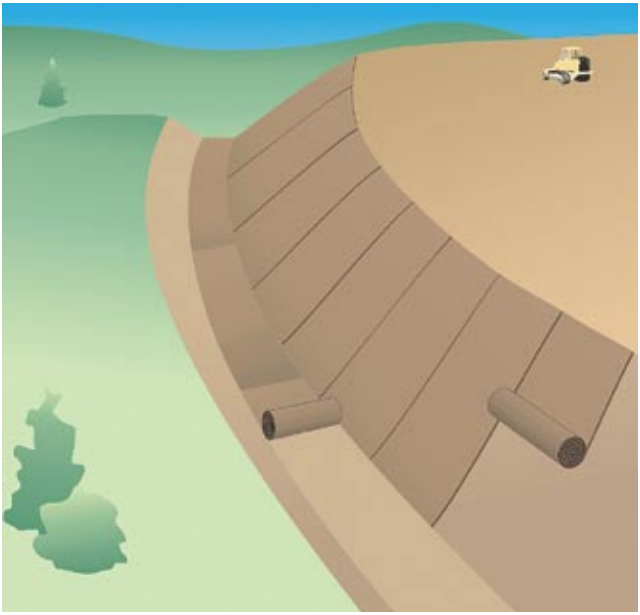
Slopes exceeding 3:1 with highly erodible soils must be protected with erosion control blankets, turf reinforcement mats, or other products such as hydraulic soil binders or bonded fiber matrices. Rock mulch and lined downdrain channels might be needed on steep slopes to control gullying.



Temporary downdrain using plastic pipe. Stake down securely, and install where heavy flows need to be transported down highly erodible slopes. Note silt check dam in front of inlet.



Temporary or permanent downdrain using geotextile underliner and riprap. All slope drains must have flow dissipaters at the outlet to absorb high energy discharges, and silt checks at the inlet until grass is established.



Steep, long slopes need blankets or mats. Install blankets and mats up and down long slopes. For channels below slopes, install horizontally. Don't forget to apply seed, lime, and fertilizer (if used) before installing blanket.

Soil conditions vs. erosion

If soil is:	Erosion will be:
Compacted and smooth	30 percent *more*
Tracks across slopes	20 percent *more*
Tracks up & down slopes	10 percent *less*
Rough and irregular	10 percent *less*
Rough & loose to 12" deep	20 percent *less*

Chemical soil stabilizers and hydraulic mulch

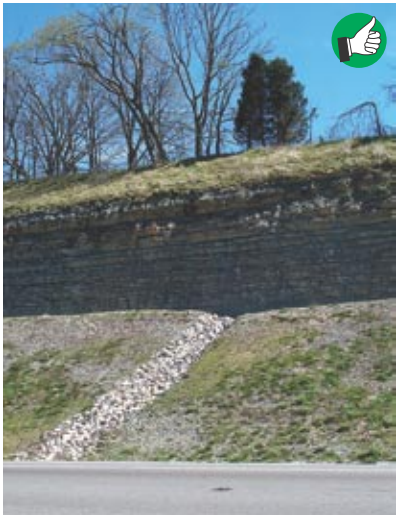
Anionic polyacrylamide (PAM) and other chemical soil binders and stabilizers have been proven effective in controlling erosion on slopes. Do not use these products within 25 feet of natural waterways. Follow manufacturer recommendations regarding mixing and application. Keep equipment off treated areas.

Note that this protection is only temporary—repeat applications or seeding and mulching or other action is still needed for permanent slope protection. Bonded fiber matrices and other hydraulic mulch products applied after seeding or with seed in the mix can provide permanent protection if mixed and applied properly. Apply 1 to 2 tons per acre; follow manufacturer's directions.

Excellent soil conditioning (dozer tracking) prior to seeding and straw-blowing. Seed and mulch provide cheap, excellent protection. Use blankets on slopes if they are steep or soils are poor.

Excellent slope protection with seeding and erosion control blanket. Blankets or mats are required on most projects if slopes are 3:1 or steeper. KYTC requires blankets on all slopes longer than 100 feet if they are 4:1 or steeper.

Excellent use of temporary plastic covering during bridge construction to reduce slope erosion. Filter sediment from pump discharges or discharge to protected infiltration area away from waterways.



Very good application of rock lined downdrain channel to carry water down slope face. Use filter fabric under rock. Install multiple drains at appropriate spacing where flows are heavy. Install flow dissipaters at outlet to absorb energy of the discharge.

Very good use of 20-inch plastic slope drain pipes to convey water from roadway to lower channel. Note staking and rock anchoring at bottom of temporary slope drain pipes.

Good use of rock-filled, stacked gabion baskets to protect steep slope. Soil and bark mulch can be used in or over gabions and planted with live willow or hardwood cuttings to reduce "hardened" look.

Good use of engineered retaining wall to break up slope. Development site and customer preferences will dictate type of materials used.

Poor slope protection. Seed has washed away—blankets or mats should have been used. Channel lining is poor. Silt check dam has washed out; more silt checks are needed.

Very poor slope protection. For best results, prepare soil and apply seed with mulch or blanket immediately after reaching final grade.

SECTION 7

Protecting Culvert and Ditch Inlets and Outlets

Culverts and ditches are designed to carry moderate and large flows of storm water. They can transport a lot of sediment to streams, rivers, wetlands, and lakes if they are not properly protected. In addition, culvert and ditch outlets can become severely eroded if high velocity flows are not controlled.

Culvert and storm drain ponding methods

Muddy runoff that flows toward a culvert, ditch, or storm drain inlet must be slowed down and pooled or filtered to settle out and remove sediment. This can be accomplished by placing rock, reinforced silt fencing, silt dikes, or other barrier in front of the inlet. The goal is to cause ponding of the inflow so sediment can settle out, and allow ponded water to enter the inlet only after sediment has been removed.

Straw bales alone are not approved for inlet protection. The next section describes several inlet protection devices. If the drainage area above the inlet is greater than three acres, a sediment trap or basin is be needed (see Section 9). For all inlet protection approaches, seeding and/or mulching upland areas promptly will greatly reduce incoming runoff volumes and sediment loads

Inlet protection devices

Inlets can be protected with structures made of rock, reinforced silt fence, stone-filled bags, or commercial “inlet dam” products. Accumulated sediment must be removed after each rain to ensure effectiveness. Place materials to form a small dam around the inlet. Build larger dams farther away from inlets with heavy incoming flows. When using rock, mix rock of various sizes so flows can seep through the dam slowly (see photos on following pages). If spaces between rocks are too large, runoff will move through the dam without adequate settling time.

Silt fence dams can be used in low flow areas. Install a wire-reinforced silt fence dam or box around the inlet (see Section 5). Use diagonal bracing on

sides and/or top to protect against incoming flow pressures. Make sure fence is trenched in and securely fastened to posts. Repair bypasses and undercuts promptly.

Place removed sediment in areas where it will not wash into inlets, ditches, channels, or streams. **Do not wash sediment or any other material down curb, channel, or drain inlets.**

Excellent use of concrete blocks and #57 rock for ponding dam to protect inlet. Note 2"x 4" board through blocks for stabilization. Note galvanized fencing and filter fabric between block and rocks.

Very good design and installation of inlet protection ponding dam using concrete blocks and rock. Outlet pipe in background has a rock apron to dissipate flows.

Good application of silt fence frame to protect inlet. Use wire fence backing to reinforce frame, or diagonal bracing across top of stakes. Make sure fence is trenched in to prevent bypasses or undercutting. Inspect and remove sediment as necessary after each rain.

Very good application of mixed rock for culvert inlet ponding dam. Mixing rock promotes better ponding, drainage, and settling of sediment.

Poor protection for drop inlet on concrete pad. Straw bales make good mulch but are not suited for inlet protection or silt check dams.

Poor placement of stone bag inlet dam; poor education of construction site drivers. Bags work well if used properly and maintained. Bags must form a dam around the inlet with no large gaps.

Poor placement and poor maintenance of stone bag inlet ponding dam. Accumulated sediment must be removed and dam should be repaired after each half-inch rain.

Straw bales have rotted and failed, with muddy runoff undercutting bales. Concrete apron and drop inlet grate are nearly covered in sediment. Use straw for mulch only.

Outlet protection methods

Outlets for storm drains, culverts, and paved channels that discharge into natural or constructed channels must be lined with rock or other armoring to prevent downstream bank and channel erosion when flow velocities are high.

The rock-lined "apron" at the outlet must be straight (lined up with the discharging pipe or channel) and laid in flat. Bring the sides up around outlet to prevent erosion, and up the banks a little to prevent scouring. The apron is shaped like a long triangle, with the narrow end located at the outlet and sized about 3 times the diameter of the outlet pipe. The width of the downstream end of the apron will be wider, tied into the channel, and vary according to the shape of the channel it empties into.

The table below provides general information for sizing rock and outlet aprons for various sized pipes. Outlets that discharge high flows must follow the maximum suggested sizing criteria.

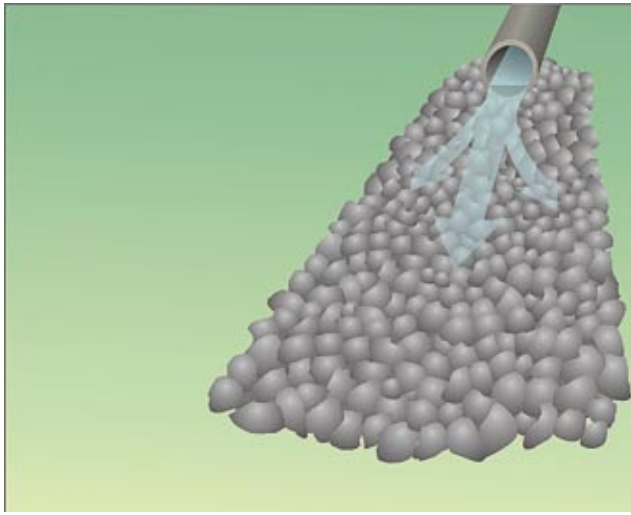
Sizing for flow dissipaters at culvert outlet

Culvert size	Avg. rock diameter	Apron width*	Apron length**	Apron length***
8"	3"	2–3 ft.	3–5 ft.	5–7 ft.
12"	5"	3–4 ft.	4–6 ft.	8–12 ft.
18"	8"	4–6 ft.	6–8 ft.	12–18 ft.
24"	10"	6–8 ft.	8–12 ft.	18–22 ft.
30"	12"	8–10 ft.	12–14 ft.	22–28 ft.
36"	14"	10–12 ft.	14–16 ft.	28–32 ft.
42"	16"	12–14 ft.	16–18 ft.	32–38 ft.
48"	20"	14–16 ft.	18–25 ft.	38–44 ft.

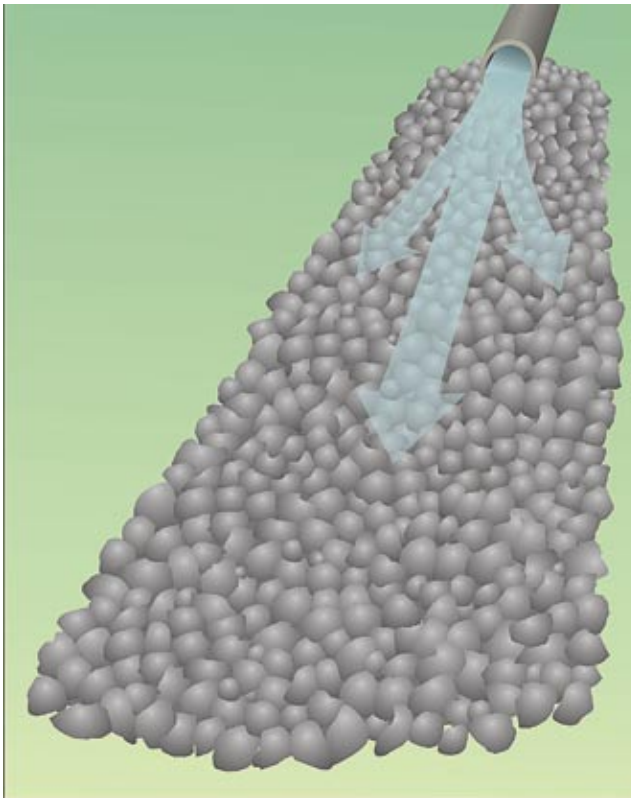
** Apron width at the narrow end (pipe or channel outlet)*
*** Apron length for slow-flow (no pressure head) culverts*
**** Apron length for high flow (pressure head) culverts*

If the culvert outlet and receiving channel do not line up straight, the channel bank receiving the brunt of the outlet flow must be lined or it will erode quickly. If rock will be used, double the average diameter when sizing the rock needed. Gabion baskets—galvanized wire mesh boxes filled with rock—are often used in this

situation, and can be stacked to form a wall if necessary. Mulch and soil can be mixed with the rock in the baskets to promote growth of stabilizing vegetation if desired.



Low-flow energy dissipaters (above) are shorter than those for high-flow outlets (below).



Good placement and construction of rock apron at high-flow culvert outlet. If flow from culvert enters a channel, make sure channel is lined with grass, and blankets or mats, if necessary, to prevent erosion.

Excellent placement and construction of rock apron to dissipate flows from culvert outlet. Area needs seeding and mulching.

Good silt fence installation, fair seeding and mulching on slopes. Poor placement and construction of flow dissipater apron at culvert outlet.

Poor rock apron placement and construction at culvert outlet; poor seeding and slope protection (right side).

Poor slope protection, no rock apron or flow dissipater at culvert outlet. Silt fence must not be used across ditches or channels; do not put sediment traps at culvert outlets.

Poor seed and mulch application, slopes badly eroding. No rock apron or flow dissipater at culvert outlet. Culverts clogged with sediment and rock.

Very poor outlet protection. No slope protection or seeding, no rock apron or flow dissipater at culvert outlet. Misapplication of silt fence across ditch. Flow bypass.